

## ATTACHMENT: THREE

Project: EXTERIOR FACADE RESTORATION  
**Milwaukee Public Museum**  
800 West Wells Street  
Milwaukee, WI 53233-1478

Project Number: O114-11436

Subject: **Milwaukee Public Museum Marble Façade**  
**By**  
**GRAEF, Inc.**  
December, 2010

# **MILWAUKEE PUBLIC MUSEUM MARBLE FAÇADE**

**800 West Wells Street  
Milwaukee, WI 53233**

Prepared for

## **MILWAUKEE COUNTY**

City Campus  
2711 West Wells Street  
Milwaukee, WI 53208

**DECEMBER 2010**

Prepared by

## **GRAEF**

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**Project No. 2010-0161**

**Milwaukee Public Museum Facade  
Milwaukee County**

**2010-0161**

Prepared for: Milwaukee County  
City Campus  
2711 West Wells Street  
Milwaukee, WI 53208

Site Address: 800 West Wells Street  
Milwaukee, WI 53233

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## 1. EXECUTIVE SUMMARY

The Milwaukee Public Museum (MPM) is located on the north side of Wells Street between James Lovell Street and 9<sup>th</sup> Street. The MacArthur Square Park is on the north side of the building. The building ranges in height from a single story to eight stories and is mostly clad in limestone panels. The north and south elevations of the eight story section of the building are clad in marble. The Discovery World and I-Max portions are clad in precast panels.

The scope of this evaluation was to review the previous reports performed by others, the existing building drawings, and perform a visual evaluation of the condition of the marble clad areas of the center eight story portion of the building.

Marble is inherently a more porous material than most wall veneer systems and many items have led to the deterioration of the support system of the panels and resulted in cracking and spalling of the marble veneer. Moisture has infiltrated the wall behind the panels due to years of weathering with freeze-thaw cycles, missing weep-holes, insufficient design of the wall assembly, lack of maintenance of the joints between the panels, and deterioration of the coping stone.

The existing marble is an architectural statement long associated with this building. With proper repair, replacement and the addition of drainage items, repairing the marble could be a long lasting solution. Repair of the marble, including the replacement of some of the panels, is estimated to cost approximately \$1.4 million. However, repair of the marble will always be obvious because there will be some replacement panels which will always vary slightly in color from the original panels.

A number of options were explored for replacing the marble with other materials and systems. If the existing marble panels were used on the north face and new stone panels were used on the south face, it would cost approximately \$1.5 million. Granite would produce a very similar look to the existing façade but is the most expensive option at about \$2.1 million. A high-end composite metal wall panel has variations in finish of appearance and colors and is estimated to cost about \$1.4 million. A premium finish on a very well-detailed and installed Exterior Insulated Finish System (EIFS) is estimated to cost approximately \$1 million.

We recommend that the existing marble panels be removed, the shelf angle be repaired or replaced, a proper flashing system be installed, and then re-install the existing marble on the north face and provide new stone panels on the south face. If sufficient funds are not available for this option, then we recommend reusing the existing panels and placing the replacement panels in unobtrusive locations. If the panel replacement project is delayed more than one year, we recommend resealing the joints and monitoring the façade condition twice a year.

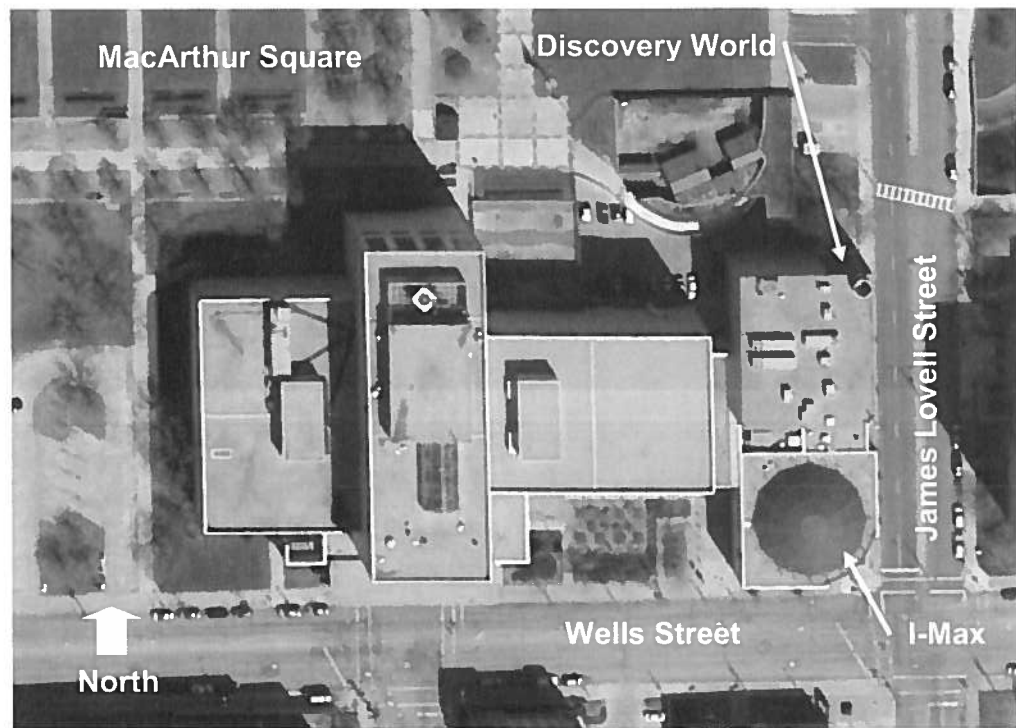
## 2. BUILDING DESCRIPTION

### 2.1. Building Description

The Milwaukee Public Museum (MPM) is located on the north side of Wells Street between James Lovell Street and 9<sup>th</sup> Street. The MacArthur Square Park is on the north side of the building.

The building ranges in height from a single story to eight stories. The northeast and southeast portions of the building house the Discovery World Museum and the I-Max Theater respectively and were additions to the original building. There is a garage on the north side of the building adjacent to MacArthur Square.

The majority of the building is clad in limestone panels. The north and south elevations of the eight story section of the building are clad in marble. The Discovery World and I-Max portions are clad in precast panels.



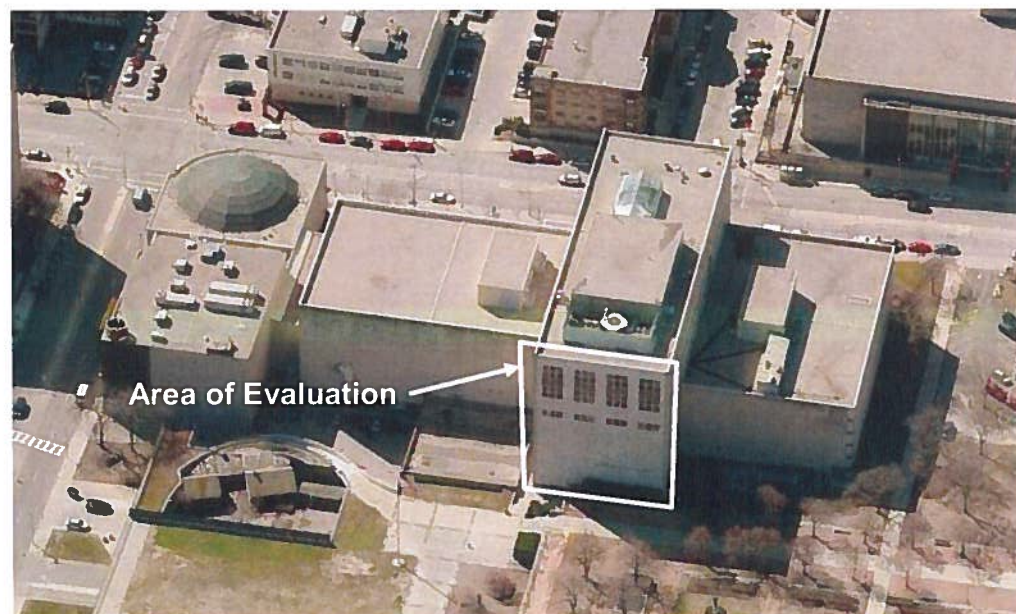
Site Plan

### 2.2. Project Scope

The scope of this evaluation was to review the previous reports performed by others, the existing building drawings, and perform a visual evaluation of the condition of the marble clad areas of the center eight story portion of the building.



View from the south



View from the north

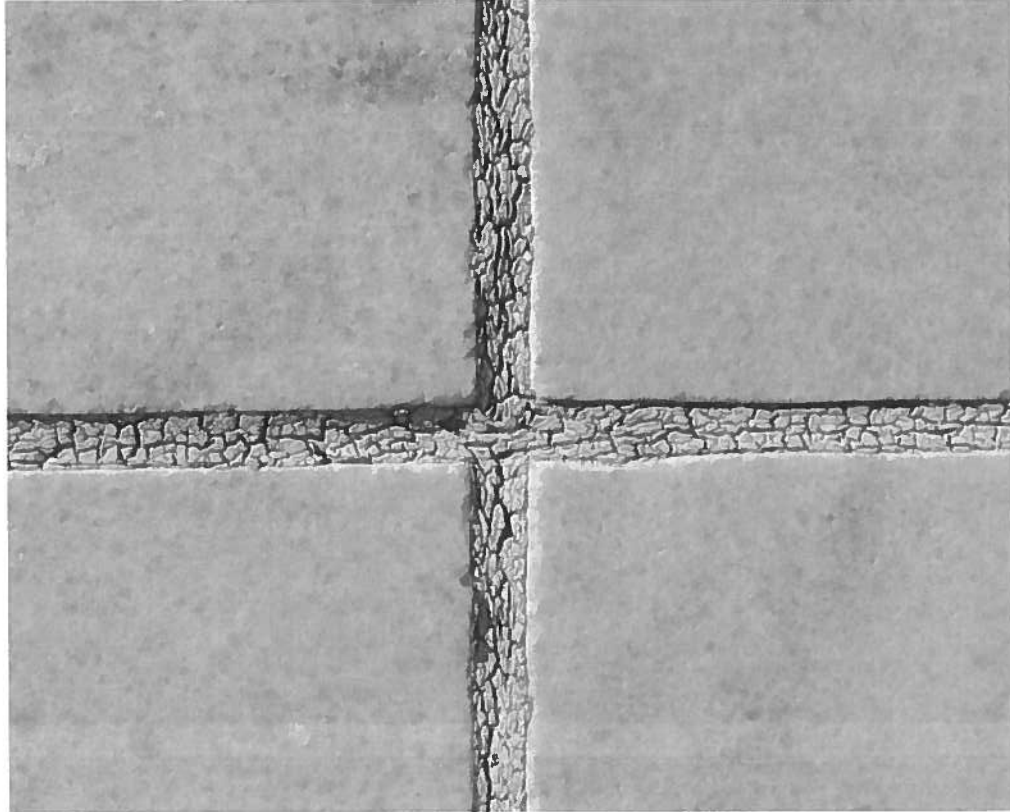
### 3. INFORMATION OBTAINED

#### 3.1. Tremco Report

Tremco of Southeastern Wisconsin performed an inspection of the roof and the exterior wall conditions at the MPM in the Spring of 2009.

In the portion of their report related to the walls, they noted that the through-wall flashing under the parapet coping stone was severely deteriorated and cracked. Additionally, the joints between the coping stones were cracked and deteriorated and need to be tuck pointed.

The report also noted that all of the existing urethane sealant joints within the marble areas on the north and south elevations need to be cut out, cleaned, primed, backed and sealed using a one-part urethane sealant. They also noted that the same process of repair is required for all sealants around the windows on the north façade.



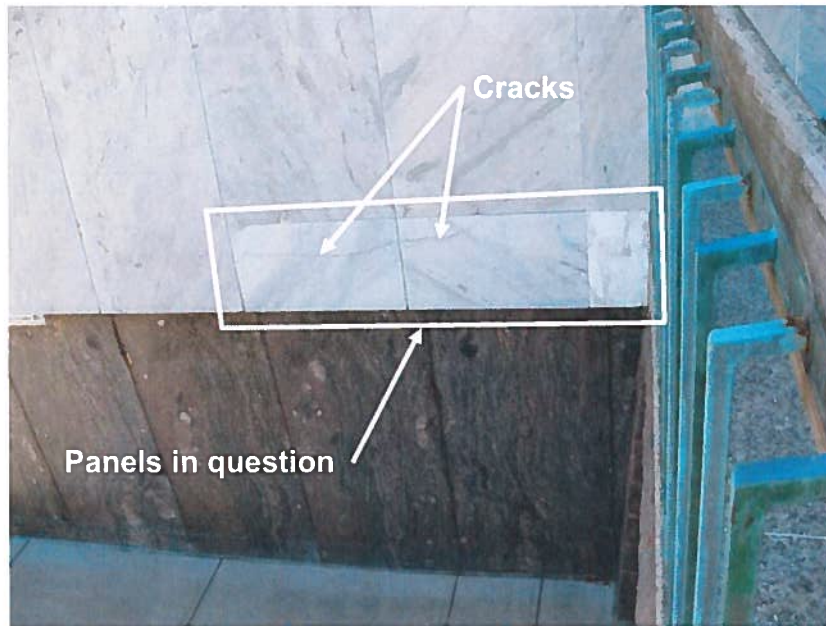
Cracked joints between marble panels

### **3.2. Existing Drawings**

Drawings from the 1977 repair of the facades were reviewed. These drawings indicate that the marble is "Georgia White Marble" with a honed face. The drawings also indicate numerous joints were repaired, with various panels removed and repaired as well.

In particular, the following notes indicate that repairs were planned and presumably completed in areas that are presently failing again. Drawing sheet 1 of 5 called for "new ½" expansion joints in top course of stone" of the south façade. Sheet 3 of 5 indicated that "3 stone panels" at the plaza level of the north façade were to be removed, repaired and reset. Two of those panels have cracked again and none of the three match the original panels in color; it is probable that these were replaced after being removed rather than repaired and reset.





Cracked replacement panels

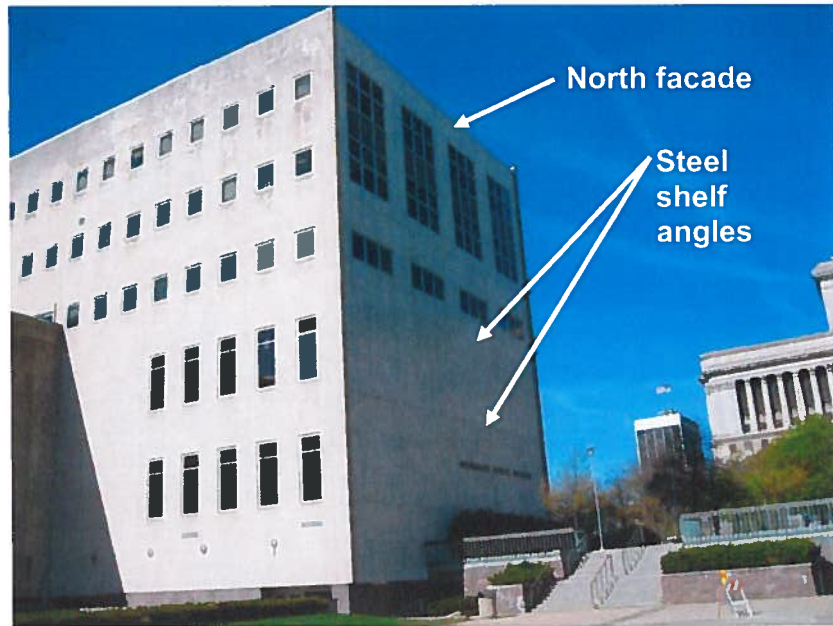
#### **4. OBSERVATIONS**

The following comments are based upon a review of the existing drawings and the on-site survey, and are illustrated with additional photos taken on April 26, 2010.

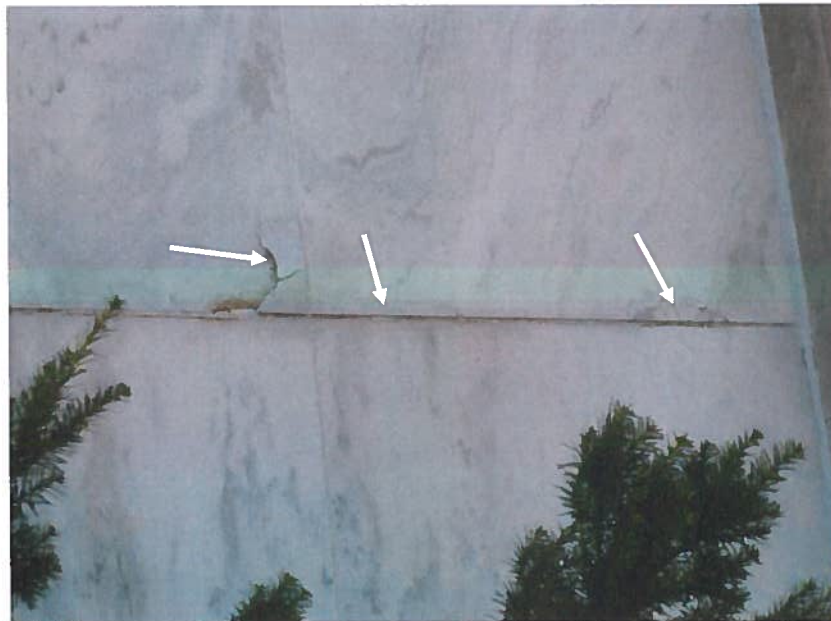
The north and south façade are veneered in white marble panels, approximately 4 feet wide by 6 feet tall and are supported on a steel shelf angle at every third row of panels. The east and west facades are finished in limestone and are not part of this investigation. We concur with the Tremco report that the joints are in need of removal and replacement.

##### **4.1. North Façade**

The north façade faces MacArthur Square Park, which is also bounded by the police headquarters, the county courthouse and the county jail. The north façade shows evidence of prior repair and replacement of some marble panels as well as continued cracking of the marble. The replaced panels were not an exact match and the color difference can easily be seen. These replaced panels have also cracked, emphasizing that the underlying problem of directing the moisture has not been resolved. Additionally, joints around the window system are deteriorating as well.



North facade facing MacArthur Square



Cracking of marble panels on north facade



Replaced panels with new cracks



Cracked marble at joints

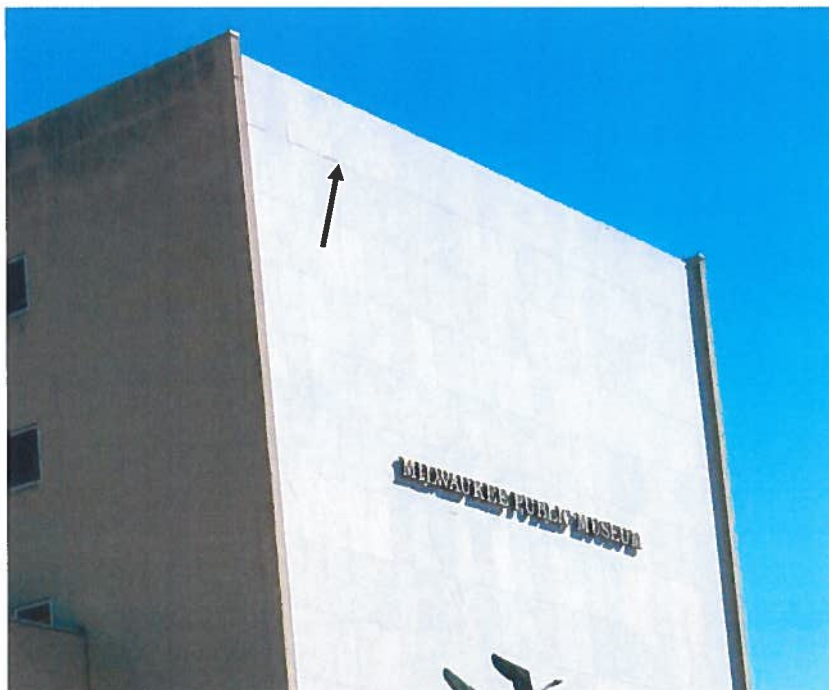
#### 4.2. South Façade

The south façade of the center portion of the building faces West Wells Street and also shows evidence of joint failure and cracking marble.

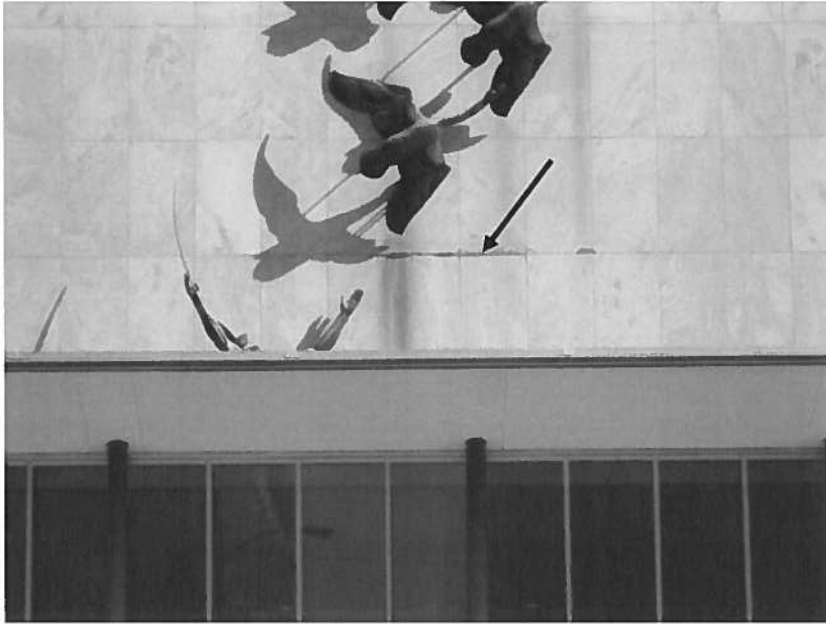


South Façade

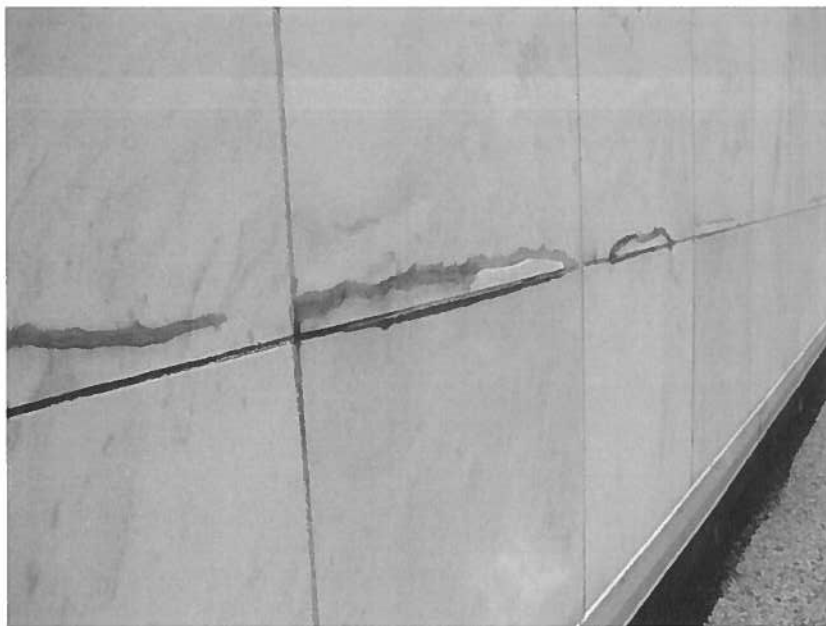
As seen in the photo below, there is some movement and deterioration of the joints just below the top course of panels, which were repaired in 1977.



The joints between rows of panels show evidence of failure of the support system with joints cracked and panels pulling away from the building. Many of these cracks have been patched in the past and are failing again.



Previously patched and failing joints just above the main entry



Close-up view of failing joints and cracked marble





Cracked and failing joints and previous repairs

The deterioration of the joints may also begin to impact the roofing of the main entry; the joint above the metal flashing has failed and allowed the base flashing to pull away from the wall. This allows moisture to work its way into the wall and under the roofing, eventually leaking onto the ceiling of the lobby area.

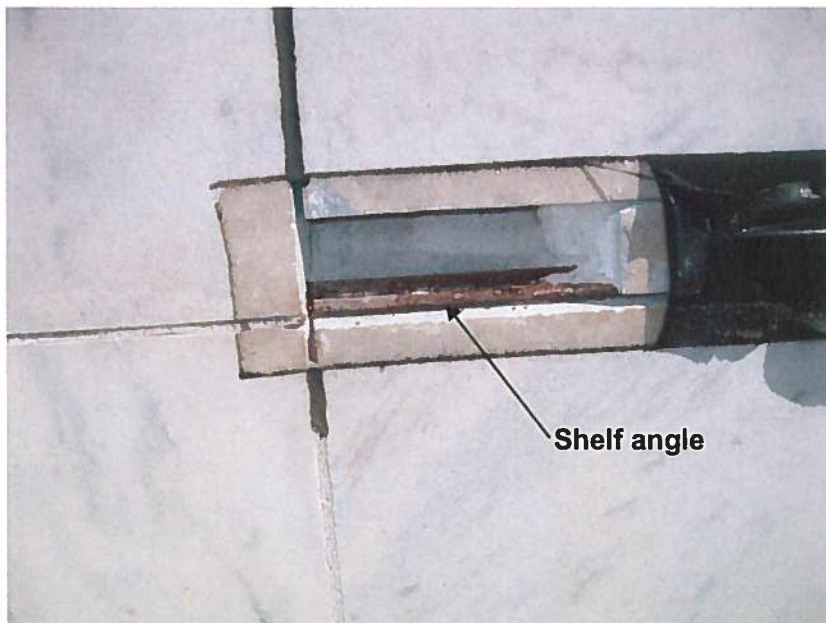


Deterioration of joint at base flashing to lower roof

Currently, the marble panels are attached to the concrete masonry unit backup wall with steel shelf angles located at every third row of panels. The shop drawings indicated that these are continuous steel angles with continuous bars; there is no flashing indicated on the drawings. The only opportunity for drainage if moisture gets into the wall is behind the angle in areas where the angle is shimmed out. One area of the south façade wall that included an angle was opened up and is shown below. In keeping with the shop drawings, no flashing was observed.



Exploratory patch on south façade at shelf angle





Deteriorating shelf angle



Shelf angle with no flashing



## **5. ALTERNATIVES**

The primary problem with the marble façade is its lack of watertight integrity and its inability to shed the water that does get behind the stone. There are a number of ways the problems identified can be addressed.

The best long-term solution would be to completely remove the marble panels, repair or replace the shelf angle, install the proper flashing system, and then re-install the existing marble, supplemented with some replacement panels, or attach another wall veneer system. A short-term delaying tactic would be to reseal the existing joints to minimize water infiltration until the proper restoration could be accomplished.

### **5.1. Resealing the Joints**

Resealing the joints would temporarily restore some of the façade's watertight integrity. However, this alone would not provide a way to release the water that would make its way behind the stone. Therefore, the deterioration that is present will continue. This will result in a continuation of stone pieces falling from the façade and will eventually result in the loss of structural support for the stone façade. All of the joints should be removed and replaced as identified in the Tremco report.

### **5.2. Repairing the Support Angles and Replacing the Marble**

Once the marble veneer panels are removed, an assessment can be made of the extent of deterioration of the shelf angles. It is possible that the angles could be cleaned, repainted and reused. If the shelf angles cannot be salvaged, they should be replaced with new galvanized angles. A new flashing system should be designed, detailed and installed, and the marble reattached with new or additional ties. Some marble panels will be beyond repair and will need to be replaced. Other panels may break during removal and reinstallation. These panels would then need to be replaced with new panels which will not match. The replaced panels will always be obvious and will always stand out from the original panels.

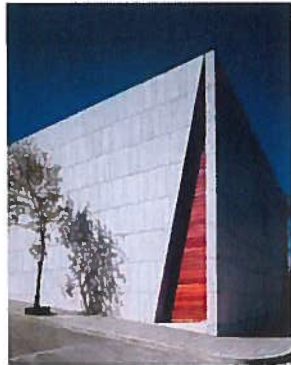
### **5.3. Options for Replacement of Marble**

#### **5.3.1. Stone and Precast Concrete**

Replacement of the marble with a stone or precast product would most resemble the original design intent. These are more durable, less porous materials and could be designed with the proper drainage, weeps and support system.

Stone can include granite, marble, limestone, sandstone and slate. Granite has a coarse grained texture but is inherently harder and more durable than marble. It could provide a similar visual appearance, although it would not be an exact match to the existing marble. The existing façade is marble and it has proven to be too porous in this climate. Limestone is currently used on the east and west facades and the same type of limestone could be used on the north and south facades.

Advantages to granite include the natural appearance similar to the original marble; disadvantages are the heavy weight of the materials and high cost of materials. Some examples are:

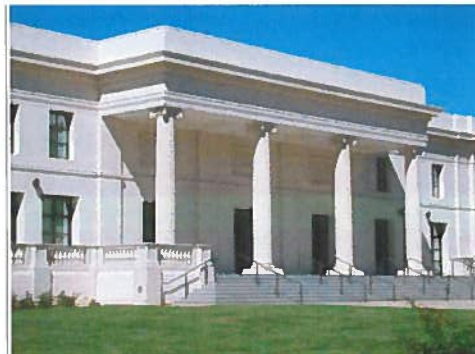


Mourning House, Mexico City, Mexico



Apartments, County Carlow, Ireland

Precast concrete can be formed in various shapes and colored in a range of hues. Advantages to precast are the control of the color, appearance of the surface, and the durability; disadvantage again is the heavy weight of the material. For example:



Huntington Library, San Marino, CA, USA

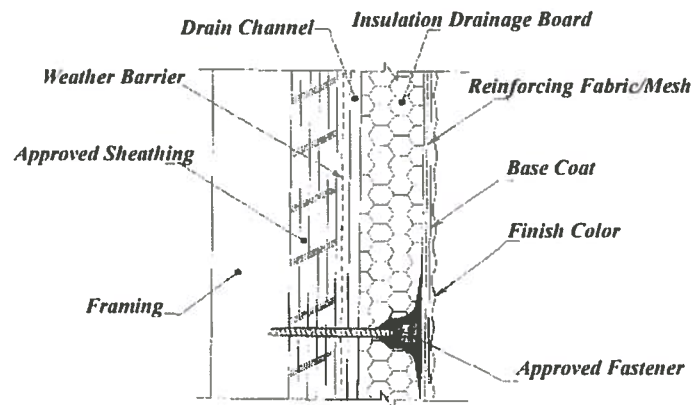
### 5.3.2. Reuse Existing Stone and Provide New Stone

In lieu of removing and replacing the marble on both elevations, there should be sufficient sound marble from both elevations to rebuild one elevation. By using the marble that was installed on the building at the same time, there should be less color variation between pieces than intermixing new marble with old. There is a possibility that there may be a slight weathering color variation between the marble installed on the north elevation as compared to the marble installed on the south elevation. Grouping marble from the same elevation together, along with pressure washing the final installation may minimize color variations. The existing marble should be installed on the north elevation, while the new stone could be installed on the front, or south elevation. The proposed new stone on the south elevation should be granite due to its durability.



### 5.3.3. Exterior Insulation Finish System (EIFS)

EIFS is a lightweight synthetic wall cladding comprised of a foam plastic rigid insulation core, a fiberglass reinforcing mesh embedded within a cementitious adhesive and finish coated with a textured coating. Advantages are the relatively inexpensive cost and the speed of installation; disadvantages can be the durability and appearance if not properly installed.



Section of EIFS construction

Examples:



CB&E Office Building, Chesterfield, MO, USA



University of Toronto, Canada

#### 5.3.4. Metal Panels

Metal wall panel systems include a variety of options from corrugated sheet metal commonly seen on outbuildings to surface embossed insulated panels that are easily mistaken for other materials. A higher finish product that achieves a lightweight panel system, increases the insulation of the building, and creates a weather repellent finish would be appropriate for this building.

Advantages include the variety in design of reveals, material color and patterns; surfaces can be embossed and factory finished in a myriad of colors, from metallic looks to those replicating stucco. Panels can be designed in grids, both vertical and horizontal linear patterns. Disadvantages include that it may be prone to a more industrial or commercial look and the requirement of a system of girts to support the panels. Some examples are:



Bartle Hall Expansion, Kansas City, MO



Graco Headquarters, Minneapolis, MN



Academy Building, Istanbul, Turkey

#### 5.3.5. Curtainwall System

A curtainwall is a non-structural outer covering designed to keep out weather elements. They are typically designed with extruded aluminum grids with infills of glass, although they can be infilled with stone, metal panels, solar panels or LED light panels.

Advantages include the variety of design options with materials and patterns, the potential for using LED or Building-Integrated Photo-Voltaic lights on the façade to also function as exhibit advertisement. The disadvantages include high cost of installation and more intensive maintenance. Some examples are:





Centipedes Building,  
Heerlen, Netherlands



GreenPix Zero Energy Media Wall,  
Beijing, China

## 6. OPINIONS OF PROBABLE COST

The following opinions of probable cost were developed using RSMeans, a nationally recognized method of estimating. Included in all items is the factor for Milwaukee construction cost index. All options include a 10% construction contingency, which we highly recommend as a minimum in a project of this type, a 15% markup by the General Contractor and 10% for Professional Design fees and Construction Administration.

### 6.1. Mobilization and Demolition

Mobilization and Demolition costs are included in all of the alternatives noted below. The following is a breakdown of some of the items included in each of those groups:

#### 6.1.1. Mobilization

Site Protection	\$ 10,000
On-site construction office	\$ 3,000
Project Manager & Superintendent	\$ 73,000
Equipment	\$ 77,000
Bond & Insurance	\$ 62,000
<b>Total</b>	<b>\$225,000</b>

#### 6.1.2. Demolition

Related roofing and flashing removal & replacement	\$ 1,000
Marble and window removal	\$ 185,000
Steel support removal	\$ 2,000
<b>Total</b>	<b>\$ 188,000</b>

### 6.2. Repair and Replacement Options

All of the following options for repair or replacement include the above noted mobilization and demolition costs.

**6.2.1. Repair and Reinstallation of the Existing Marble**

Mobilization	\$ 225,000
Demolition	\$ 188,000
Related roofing replacement	\$ 5,000
Repair (with selective replacement) Marble	\$ 468,000
New Aluminum Windows	\$ 127,000
Supports, flashing & sealants	\$ 23,000
General Contractor	\$ 155,000
Contingency	\$ 104,000
Professional Design and Construction Administration	<u>\$ 103,000</u>
<b>Total</b>	<b>\$1,398,000</b>

**6.2.2. Reinstallation of Marble and Replacement with Granite**

Mobilization	\$ 225,000
Demolition	\$ 188,000
Related roofing replacement	\$ 5,000
Reinstall (modify) Marble- (North Elevation)	\$ 58,000
Granite-a low priced grey color- (South Elevation)	\$ 508,000
New Aluminum Windows	\$ 127,000
Supports, flashing & sealants	\$ 23,000
General Contractor	\$ 170,000
Contingency	\$ 114,000
Professional Design and Construction Administration	<u>\$ 114,000</u>
<b>Total</b>	<b>\$1,532,000</b>

**6.2.3. Replacement with Granite**

Mobilization	\$ 225,000
Demolition	\$ 188,000
Related roofing replacement	\$ 5,000
Granite-a low priced grey color	\$ 977,000
New Aluminum Windows	\$ 127,000
Supports, flashing & sealants	\$ 23,000
General Contractor	\$ 232,000
Contingency	\$ 155,000
Professional Design and Construction Administration	<u>\$ 154,000</u>
<b>Total</b>	<b>\$2,086,000</b>

**6.2.4. Replacement with Metal Wall Panel System**

Mobilization	\$ 225,000
Demolition	\$ 188,000
Related roofing replacement	\$ 5,000
Metal Wall Panels with 2" Insulation	\$ 478,000
New Aluminum Windows	\$ 127,000
Supports, flashing & sealants	\$ 23,000
General Contractor	\$ 157,000
Contingency	\$ 105,000
Professional Design and Construction Administration	<u>\$ 104,000</u>
<b>Total</b>	<b>\$1,412,000</b>

#### **6.2.5. Replacement with Exterior Insulated Finish System (EIFS)**

Mobilization	\$ 225,000
Demolition	\$ 188,000
Related roofing replacement	\$ 5,000
EIFS	\$ 184,000
New Aluminum Windows	\$ 127,000
Supports, flashing & sealants	\$ 12,000
General Contractor	\$ 111,000
Contingency	\$ 74,000
Professional Design and Construction Administration	<u>\$ 74,000</u>
<b>Total</b>	<b>\$1,000,000</b>

### **7. RECOMMENDATIONS**

We recommend that the existing marble panels be removed, the shelf angle be repaired or replaced, a proper flashing system be installed, and then re-install the existing marble on the north face and provide new stone panels on the south face. If sufficient funds are not available for this option, then we recommend reusing the existing panels and placing the replacement panels in unobtrusive locations. If the panel replacement project is delayed more than one year, we recommend resealing the joints and monitoring the façade condition twice a year.





